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SOME ASPECTS OF THE BIOLOGY AND ECOLOGY OF NARCONDAM HORNBILL (*RHYTICEROS NARCONDAMI*)

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(*With one coloured & five Black-and-White plates and five text-figures*)

Introduction

Two species of hornbills of the genus *Rhyticeros* are represented in the Indian sub-continent. Of these *R. undulatus* occurs in north-eastern India, Burma down to Malay peninsula and the Mergui Archipelago. The other, *R. narcondami* is restricted to Narcondam, an off lying island in the Andaman group. Very little is known about the biology and ecology of the latter. Hume (1873) on an expedition to the Andaman group collected several hornbills from Narcondam and named it *narcondami*. Prain (1893), St. John (1898), Cory (1902) and Osmaston (1905) visited Narcondam subsequently to collect specimens. The last spent five days, (the longest period of time spent in the island by a visitor), in search of stands of the timber tree *Pterocarpus dalbergoides*. He also made some notes on the fauna and flora including Hornbills, whose number he estimated to be about 200. No further information on the hornbills was available until two of my colleagues at the BNHS, Robert B. Grubh and R. J. Pimento visited the island briefly in 1969. Abdulali (1971) visited the island in the following year and spent a few hours to collect specimens. In 1972 along with Mr. N. J. George of Prince of Wales Museum, I visited the island at the instance and direction of Mr. Humayun Abdulali. We visited South and North Andamans and Narcondam island from 4th March to 25th April 1972 and the field data and specimens collected by us were reported in the *Journal* (Abdulali 1974). The Narcondam island (the name Narcondam is derived from Sanskrit *Naraka* — Hell; *Kundam* — Pit, — an obvious reference to the origin of the island which is believed to have been an active volcano not long ago) is difficult to approach, except during the months of March, April

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and May when the sea around is comparatively calm.

The present paper records observations made by me during my stay on Narcondam from 16th March to 14th April 1972, and the subsequent observations on the two hornbill chicks brought back which lived in captivity at the Society's premises.

Taxonomical notes:

Hume (1873) while describing *narcondami* stated that it resembled *R. plicatus* of Borneo and due to the difference in size as well as the absence of a zoogeographic connecting link between these species gave the former the status of a species. Baker (1927) treated it as a full species in the absence of intermediates and stated that systematists may consider it to be a small island race of *R. plicatus* of which *R. everetti* of the Moluccas was thought to be an intermediate form. Blyth (1845) had in the meantime, described *subruficollis* from N Burma, which he differentiated from *R. plicatus ruficollis* by the absence of any ridges on the sides of bill and by its smaller size. Peters (1945) accepted this nomenclature and considered *subruficollis* a valid race of *plicatus*. Sanft (1960) who has authoritatively reviewed the family Bucerotidae, did not accept *subruficollis* as a race of *plicatus* preferring to synonymise it with *undulatus*. His argument was that *undulatus* and *subruficollis* are from the same ancestral stock, differing only in developmental stages as well as localised variations. One of the main differences is in the structure of the bill i.e. presence of ridges on the side of the basal half of the bill (= *undulatus*) and absence of it (= *subruficollis*), which according to him, are linked with sexual maturity and tend to develop as the bird becomes older. The difference in body size, according to him, was ecologically linked to the types of habitats in which they occur. Thus the larger birds of the mountainous region are *undulatus* and the smaller occurring in low hill zones *subruficollis*. However, he had overlooked two other distinct characteristics that differentiate the two. The colour pattern of the head and neck of males, colour of gular pouch, and presence or absence of a black band on throat. These patterns are apparently not linked with ecological distribution. Are they then linked with age? Does the yellow colour of gular pouch in ♂ and black band on the pouch in both female and male develop as they grow older ?[3] (Table 1).

A 16 year old specimen of *R. p. subruficollis* at the San Diego zoo shows all the characteristics of the typical *ruficollis* with blue gular pouch without the black band (K. C. Lint, pers. comm.). Under these circumstances the taxonomic and zoogeographic position of *narcondami* is quite intriguing. If one were to accept Sanft's proposition, *narcondami is a* smaller form showing immature characters of *undulatus* isolated in the islands long ago and gradually evolving into the present form (endemic ?) and in the process losing the adult characteristics of the *undulatus*. On the other hand, the *plicatus* link theory, with the recognition of *subruficollis* as a distinct subspecies of the former, would perhaps open up a new line of possibilities on the zoogeography of the region. Another species which perhaps raises

[3] Sanft, (IBIS 95: 702-703) after studying 16 museum specimens of *R. undulatus, R. subruficollis* and intermediates argued that the ranges of the two overlap with the intermediates showing characteristics of the both, and therefore *subruficollis* is synonymous with *undulatus*. However, Elbel (*Condor* 71 (4): 434-435) on the evidence of the mellophaga present in the above two species concluded that *subruficollis* is distinct from *undulatus* and is closer to *plicatus*.

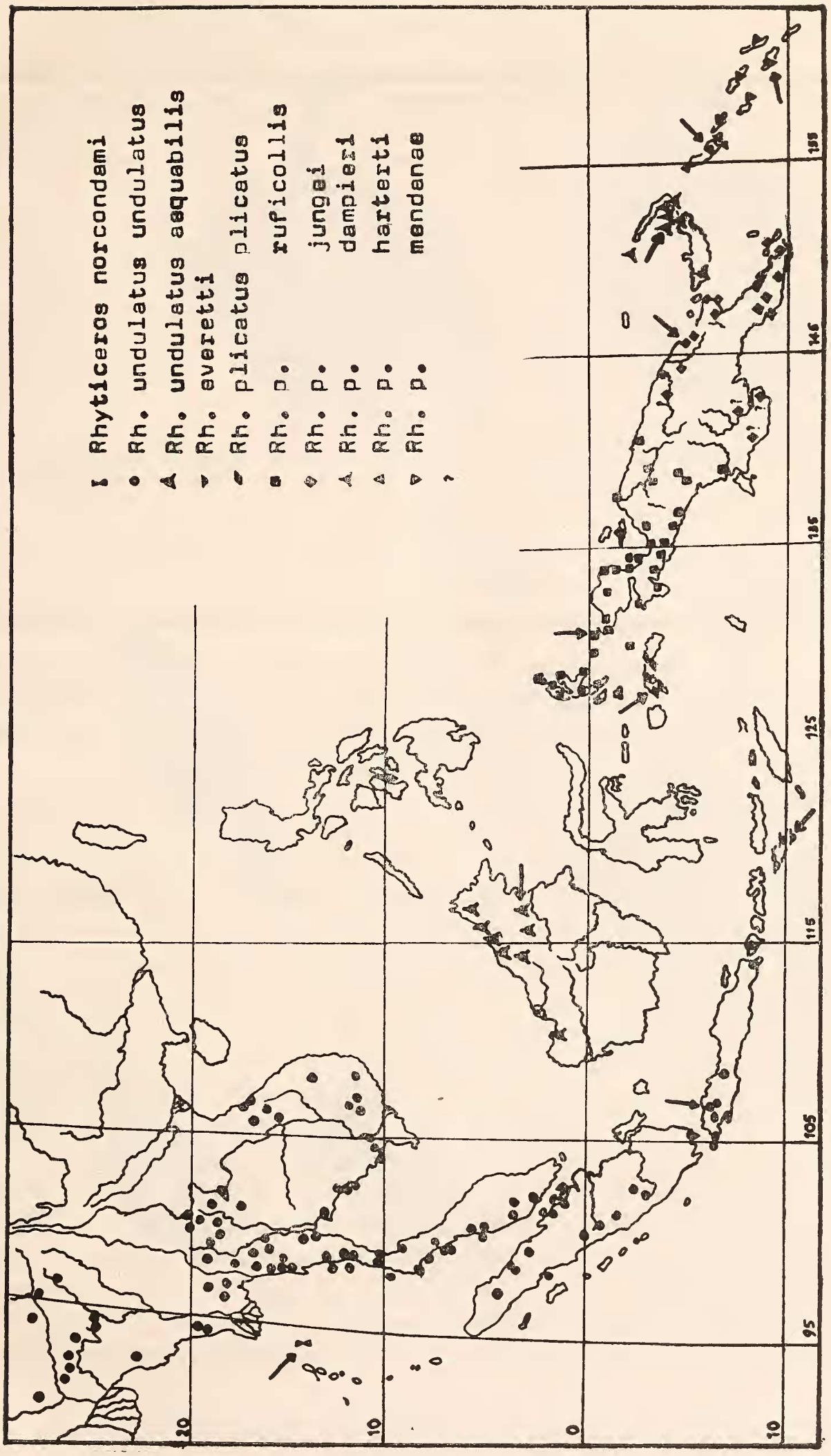


Fig. 1. Distribution of Hornbills in SE Asia (After Sanft 1960).

TABLE 1

	R. undulatus	*R. p. subruficollis*	*R. narcondami*
Bill :	Side of mandibles ridged at base	side of mandibles smooth at base	side of mandibles smooth at base
Wing :	458-505 ♂ ♀	420-445 ♂ ♀	303-305 ♂ 285-287 ♀
Weight :	2,500 gm	1,900 gm	600-750 gm
Head & Neck :	♂ dark brown crown and hindneck-almost black lower down. Throat & upper neck whitish	♂ rufous head & hind neck, white on throat	♂ rufous head and neck
Gular pouch :	Bright yellow with black band ♂ Dark blue and black band ♀	Pale blue ♂ ♀ Without black band	Pale blue ♂ ♀ without black band
Distribution :	NE India, Burma, Singapore. Sumatra, Java & Borneo	S. Burma. SW Thailand Sumatra, Borneo	Narcondam I.

similar questions is *R. everetti* an endemic of Sumba islands, SE Asia (Fig. 1). There are similarities in the evolution of these two species. Both are endemic to small islands, are smaller versions of neighbouring forms, and have distinct morphological characters (Fig. 2). Ali and Ripley (1970), followed Peters' nomenclature and called it *R.* (*undulatus*) *narcondami*. However, Ripley (1982) after seeing the live specimens in the BNHS and personal discussions with me agreed that *narcondami* is closer to *plicatus* than *undulatus*. Kemp and Kemp (1975) mention the long-hop flights of the SE Asian hornbills which sometimes cross the sea to offshore islands. These hornbills have been observed to take off from the mainland and fly in "follow the leader" formation for some distance straight out over the sea and return eventually to the starting point. Is this behaviour then an instinctive urge of a long forgotten "migratory" habit? The significance of the white tail in these hornbills which can be seen from long distances and which may probably act as a visual stimulus for the following hornbills, is worth noting.

Physiography and vegetation:

Narcondam island (13°30′ N; 94°38′ E) is situated *c* 500 km NW off Mergui archipelago and *c* 300 km SW of the Gulf of Martaban off the Burmese mainland, and *c* 125 km east of North Andaman in the Andaman and Nicobar group of islands in the Bay of Bengal. The island has a total area of about 682 hectares and is a part of a submerged chain of mountains in the Andaman archipelago. Narcondam is one of the two off-lying volcanic islands in the eastern sector of the group. It rises abruptly from the sea to a height of *c* 750 m sloping west-eastwards with a succession of steep spurs emanating from the main summit which is situated on the western portion of the island. The very mountainous nature of island (there

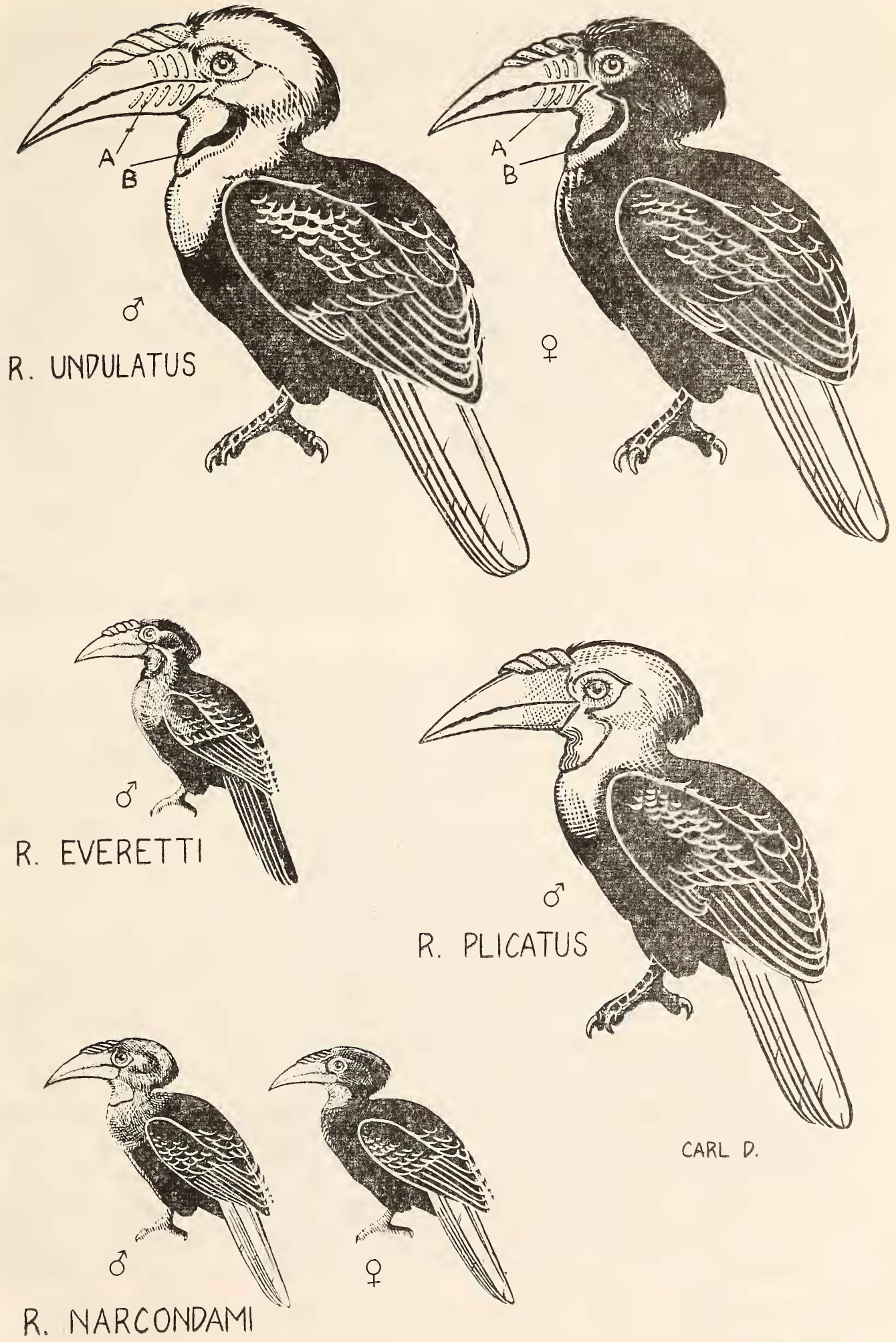


Fig. 2. Ridges and gular black band is absent in *plicatus plicatus, everetti everetti* and *narcondami.* Latter two are 1/3 the size of *undulatus* with *plicatus* being intermediate (*see* text).
Abbreviations: A — Ridges; B — Black band.

is virtually no continental shelf around the island) provides no landing place except for a small boulder-strewn bay on the southern side, which also provides the only small flat bit of ground for camping. A small spring in the bed of a dry nallah about 25 m above the sea level is the only fresh water source in the island known so far.

Climate:

The climate of the Andaman group of islands is tropical wet and humid with daily temperatures ranging from 27.8°C maximum and 21.8°C minimum. The rainfall is heavy both during SW and NE monsoons, lasting from May to October. Cyclonic storms occur during this period with rough weather conditions prevailing almost throughout the season. The average annual rainfall recorded for 17 years at Mayabunder (12°55′ N; 92°55′ E) the nearest weather station to Narcondam, is 3055.5 mm with an average of 13.4 rainy days per year. The month of July recorded highest average (538.5 m / 18.7 rainy days) and March lowest (4.8 mm / 0.4 rainy days).

Vegetation:

Parkinson (1923) and Thothathri (1960, 1962), and Balakrishnan (?) give some details of the flora of the Andaman and Nicobar group of islands. Prain (1893) described some aspects of the flora of Narcondam. The vegetation structure of the Narcondam island is more or less similar to that of the tropical N Andaman group. The vegetation can be divided into three categories (a) littoral (b) deciduous/evergreen and (c) moist evergreen. The very limited 'shoreline' of the island contains *Ipomoea biloba, Scaevola koenigi, Hibiscus tiliaceus, Pandanus* sp., *Thespesia populnea, Barringtonia speciosa* and *Sterculia rubiginosa.* Introduced plants like Coconut, Papaya and Banana grow wild in this zone. The lower hills immediately following the 'shoreline' have both deciduous and evergreen trees. Some of the typical plants of this zone are *Terminalia catappa, T. bialata, Parishia insignis,* and *Caryota mitis* interspersed with numerous thorny creepers. The flora in the higher zones of the hill contains evergreens like *Dipterocarpus* sp., *Sideroxylon* sp., *Ficus* sp. etc. The vegetation still higher and close to the summit appears to be moist evergreen, with numerous epiphytes. Some of the seeds collected from a hornbill's nest were later identified as *Anamirta cocculus, Capparis sepiaria, C. tenera* var. *latifolia, Garuga pinnata, Amoora rohituka, Terminalia catappa* and *Ixora brunniscens.* Apart from these, several other fruiting trees including the ones mentioned above no doubt occur in the island.

Mammals:

No large mammals have been recorded in the island. Large rats (*Rattus* sp.) obviously introduced, are common around the landing bay. Giant fruit bats (*Pteropus melanotus satyrus*) are common and other smaller bats may also occur.

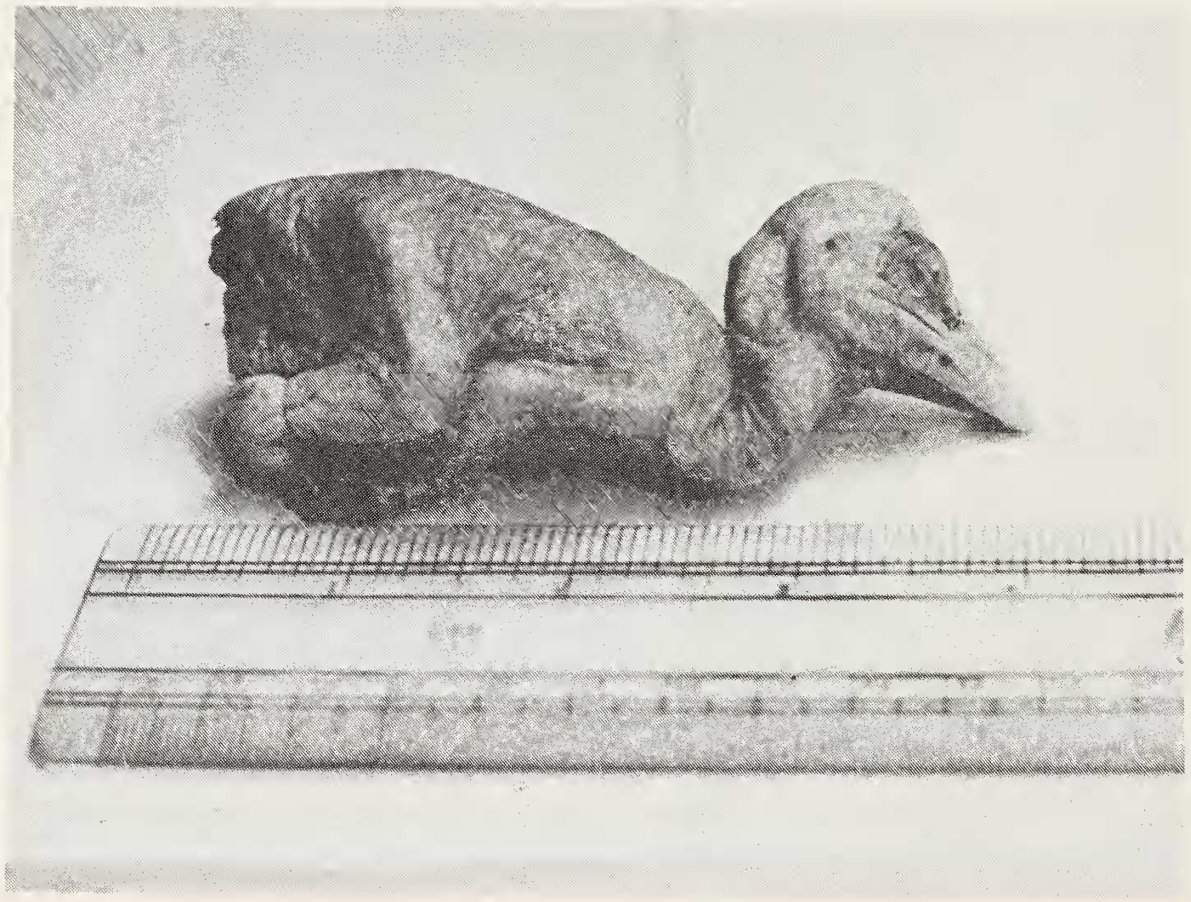
Reptiles:

One of the commonest snakes seen in the island is the flying snake *Chrysopelia paradisi* which is mostly arboreal. On the seashore occasionally sea snakes *Laticauda colubrina* are encountered. The giant water monitor *Varanus salvator* is common in different parts of the island. One specimen, which was collected, measured 1 m and weighed 4.5 kg. Skinks, *Mabuya tytleri, Lygosoma maculatus* and lizards, *Cnemaspis kandiana, Cyrtodactylus rubidus* and *Phelsuma andamanense* (endemic to Andamans) are common.

Land Crabs (*Cardisoma hirtipes*) are very

Above: Narcondam island from western side. The central peak is perpetually under a shroud of cloud.
Below: Male feeding female (and young) at nest 'B'.

(*Photos*: Pat Louis)



Above: Debris from nest 'A' (27/3/1972).
Below: A week old chick from nest (27/3/1972).
(*Photos*: S. A. Hussain)

common throughout the island, occuring even higher up in the hills. Of the invertebrates, Danaidae; Nymphalidae; Lycaenidae (Butterflies); *Chryoschroa ignita, Mimila prenceps* (Beetles); and spiders of the families Heteropidae, Aregiopidae, and Thomsidae are recorded.

Results

An attempt was made to locate as many nests of the hornbill as possible and to census the population. A regular count of all the hornbills seen each day was made (see table 2). Increase in number of the females sighted may be due to their emergence from nest confinement after a successful brooding. It was not possible to identify all the nesting trees though a few nests were spotted on *Sideroxylon* sp. and *Sterculia* sp. Most of the nests were discovered from the debris and excreta and seeds below the nest-trees while a few others by observing the movements of the male bringing food to the nest.

Table 2

NARCONDAM HORNBILL

Date	No. of ♂ seen	No. of ♀ seen	No. of nests	No. of ♂ ♀ at nest
17/iii/76	25	Nil	3	3(♂)
18	19	Nil	Nil	—
19	26	Nil	2	2(♂)
20	14	Nil	Nil	—
21	28	1 (with ♂)	Nil	—
22	31	4 (2 with ♂)	Nil	—
23	8	Nil	Nil	—
24	11	4	1	—
25	16	2	Nil	—
26	14	3	1	1(♂)
27	19	4 (2 with ♂)	Nil	—
28	16	2	1	1(♂)
29	59	11	Nil	—
30	72	28	1	—
31	40	10	—	—
1/iv/'76	31	9	—	—
2	59	14	—	—
3	13	2	—	—
4	42	12	—	—
5	39	11	—	—
6	21	8	—	—
7*	—	—	—	—
8	48	9	—	—
9	23	4	—	—
10	52	11	—	—

* Rain

Note: The birds were counted randomly each day. The numbers may be biased on certain days as the birds congregating in feeding trees were counted as well as males on feeding forays may have been counted several times over !

Fig. 3. Nest 'A' sketch.

Nesting site:

A rough estimate of the heights of the nests observed varied between 2.4 m to 15.2 m. Two nests situated at 2.5 m and 2.74 m respectively were studied in detail. The nest 'A' (Fig. 3) was situated on the outer bend of one of the main boughs of a tree facing west. The entrance, though not concealed, was not easy to spot as the ground below the nest sloped downwards steeply. The outer rim of the hole breadthwise measured 30 cm. Depth from the entrance to inner wall about 180 cm gradually tapering inwards. Nest 'B' (Plate I) was on a bare tree facing east situated about 22.9 m from nest 'A'. The ground rose into a steep ascent in front of the nest which enabled one to gaze directly into the nest hole from a certain height. The entrance measured about 25 cm with a depth of about 149 cm. The flooor of the nest was horizontal. The contents removed from nest 'A' weighed 1360 g and consisted of eight varieties of seeds apart from feathers and powdered plaster. Some of the seeds were identified by the Botanical Survey of India.

The female and the young in the nest sat with their tail held up vertically. (They continued to remain in this posture for quite some time even after they were removed from the nest.) The female attended to nest sanitation after every feeding visit of the male. She was observed tossing out what appeared to be the excreta of the young with her beak while she herself turned around and forcibly ejected her own excreta. On 6th April one of the chicks in the nest 'B' was seen making feeble attempts to defecate by bringing the anal region towards the nest entrance. Thereafter both the chicks regularly defecated in this manner.

Behaviour at nest:

The male starts fetching the food just before sunrise. No marked territorial behaviour by the breeding pair was observed. Occasionally an alien male or female was tolerated in the vicinity of the nest (i.e. on the same tree) though the minimum distance measured between two nests was about 22.8 m. Frequency of feeding varies with distance covered to the foraging tree. The shortest time recorded was 10 minutes and the longest 30 minutes. On arrival the male always perched on a particular branch of a tree depending on the direction of his arrival. If undisturbed, he would fly directly to the nest-hole, perching on a convenient branch or clinging to the nest itself and proceed feeding the female. The food is coughed up, brought to the tip of the beak which is inserted into the slit opening and is offered to the female. The number of the insertions depends on the size of the food brought in. Large berries are offered piecemeal while smaller ones, whole. No attempt was made to retrieve the food that fell down in the course of feeding. A minimum of 10 insertions were counted when berries offered were large and a maximum of 93 when they were smaller. Some times the insertions are 'false' when the female is not ready to receive the next berry. (Is she in turn feeding the young?) All this time the young would keep calling continuously. Once the feeding was over the male would clean his beak on the branch a few times and after preening himself for a while fly away on the next foraging trip.

In the beginning of my observations the male refused to approach the nest in my presence. He kept flitting from branch to branch and finally flew away. He seemed to rely on sight and showed no reactions to normal sounds but was wary of human voice. This particular male did not allow me to observe from any position *below* the line of its nest but allowed me to remain in full view at a dis-

tance of about 13·7 m, *above* the line of its nest. (This was possible as the ground rose upwards from the nesting tree).

It was not possible to ascertain the roles of the male and the female in nest building. The female in the nest 'A' was seen tamping the plaster of her nest by applying material with the sides of her bill on 18th March. The female sheds her flight feathers in the nest. The female taken out of the nest 'A' had 3rd, 4th and 5th primaries on the left wing and 3rd, 4th, 5th and 6th on the right in moult. The rest had fallen. Of the tail the 3rd pair was in moult. She weighed about 680 g, while the bill measured 108 mm, tarsus 43 mm, tail 198 mm, (moulting). She was found to be incapable of flight.

General behaviour

Call :

In flight, adults of both sexes emit a continuous 'Ka .. ka .. ka' to the accompaniment of wheezing laboured wingbeat. When alarmed, the male at nest-site calls a halting 'ko .. kokokoko .. ko .. kok .. ko kok kok kok' etc. The female inside the nest is generally silent, but sometimes utters a single 'krwak' if the male is late in offering the next morsel during the course of a feeding. If alarmed herself she emits a repeated 'Kraawk kok kok' resembling the alarm call of a frightened domestic fowl. The young inside the nest call feebly 'chew . . . chew . . . chew' continuously like a squeaking sewing machine in operation, especially when the male is feeding.

Courtship :

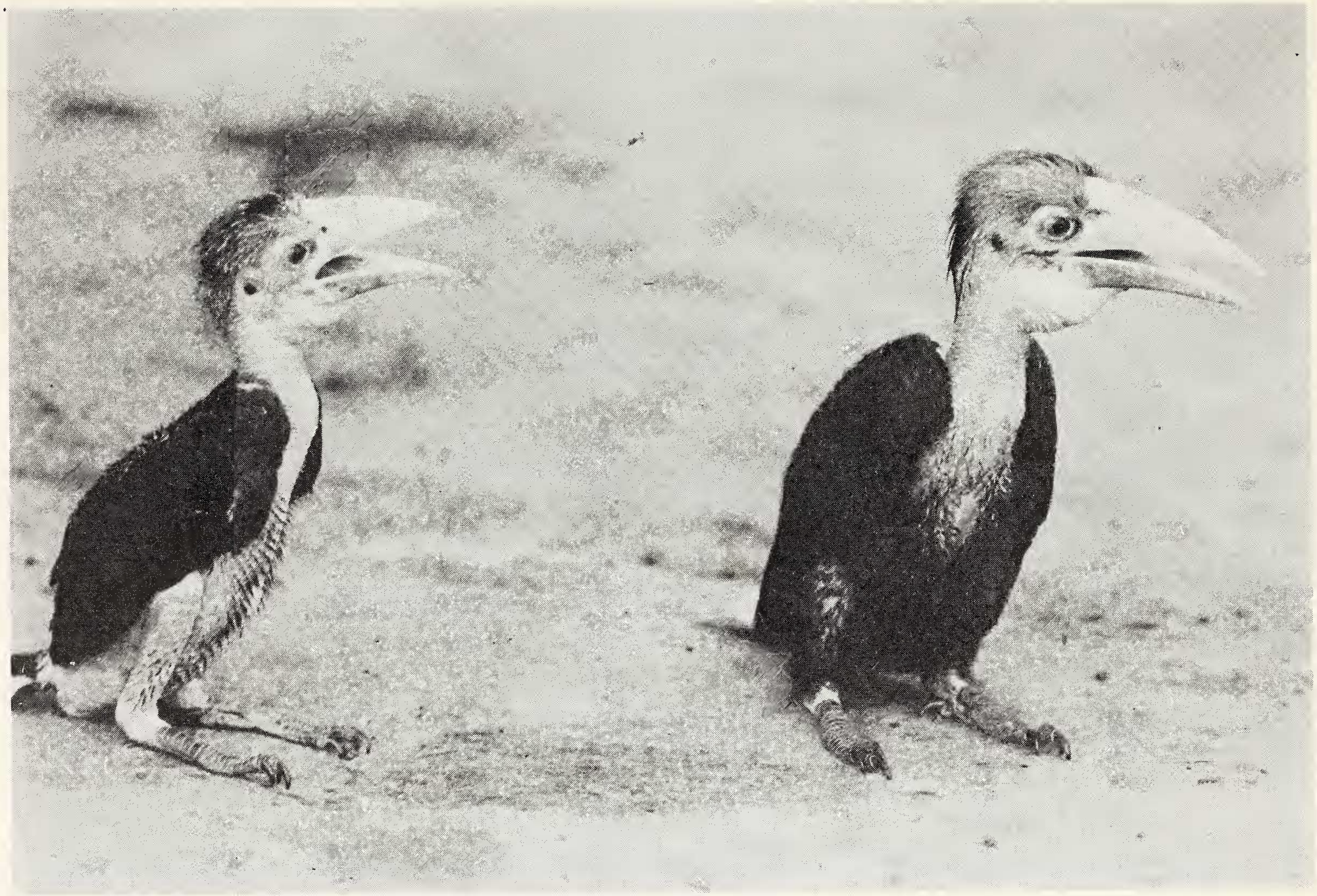
On 27th March four males and three females were seen perching on different branches of a Ficus tree. All were calling simultaneously. One pair (♂ ♀) was more active than the others. The female, which perched on the lower portion of a horizontal branch assumed begging posture towards the male perched a little higher next to her on the same branch. The male though silent now, occasionally a gave 'krawk' call and 'touched' the female's bill and hopped away. Twice the male brought out a berry and offered it to the female. This went on for sometime as both kept hopping from branch to branch and finally flew away together. Several pairs (♂ ♀) were seen together in the different parts of the island. This suggests that courtship was still in progress.

Relations with other animals :

No predators have been recorded so far but rats and water monitors are the only large animals/reptiles in the islands. Flying snakes (*Chrysopelia paradisi*) are very common and on one occasion one was observed passing on branches very close to a hornbill's nest containing a female and young. Once several hornbills were seen mobbing a whitebellied Sea Eagle (*Haliaeetus leucogaster*) from tree to tree. Abdulali (op. cit.) also mentions similar occurrence earlier. A koel (*Eudynamys scolopacea*) was also seen being chased by a hornbill. Human presence in the island is a recent phenomenon and though the impact of their presence throughout the year could not be assessed it may be assumed that the nesting pattern of the hornbill, may be affected as they would avoid nesting on lower available sites due to disturbance/predation by man.

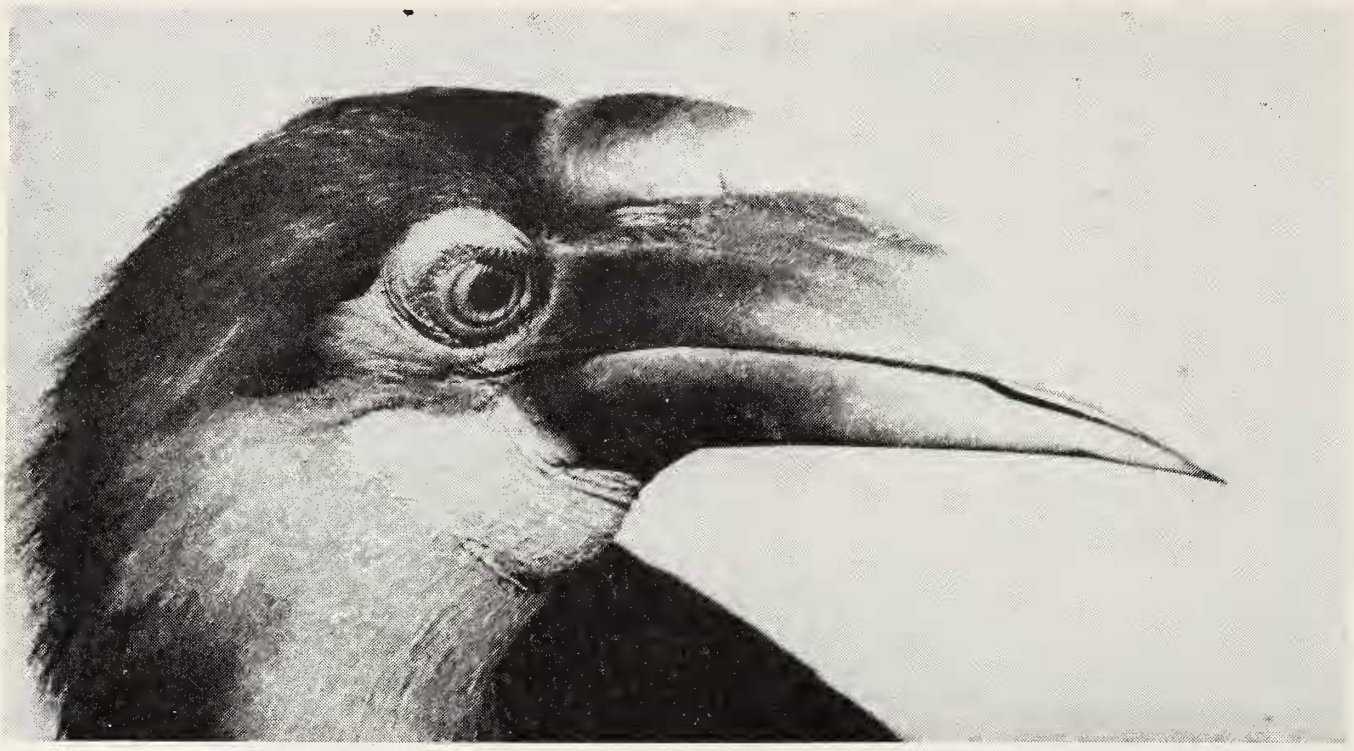
Development of the young :

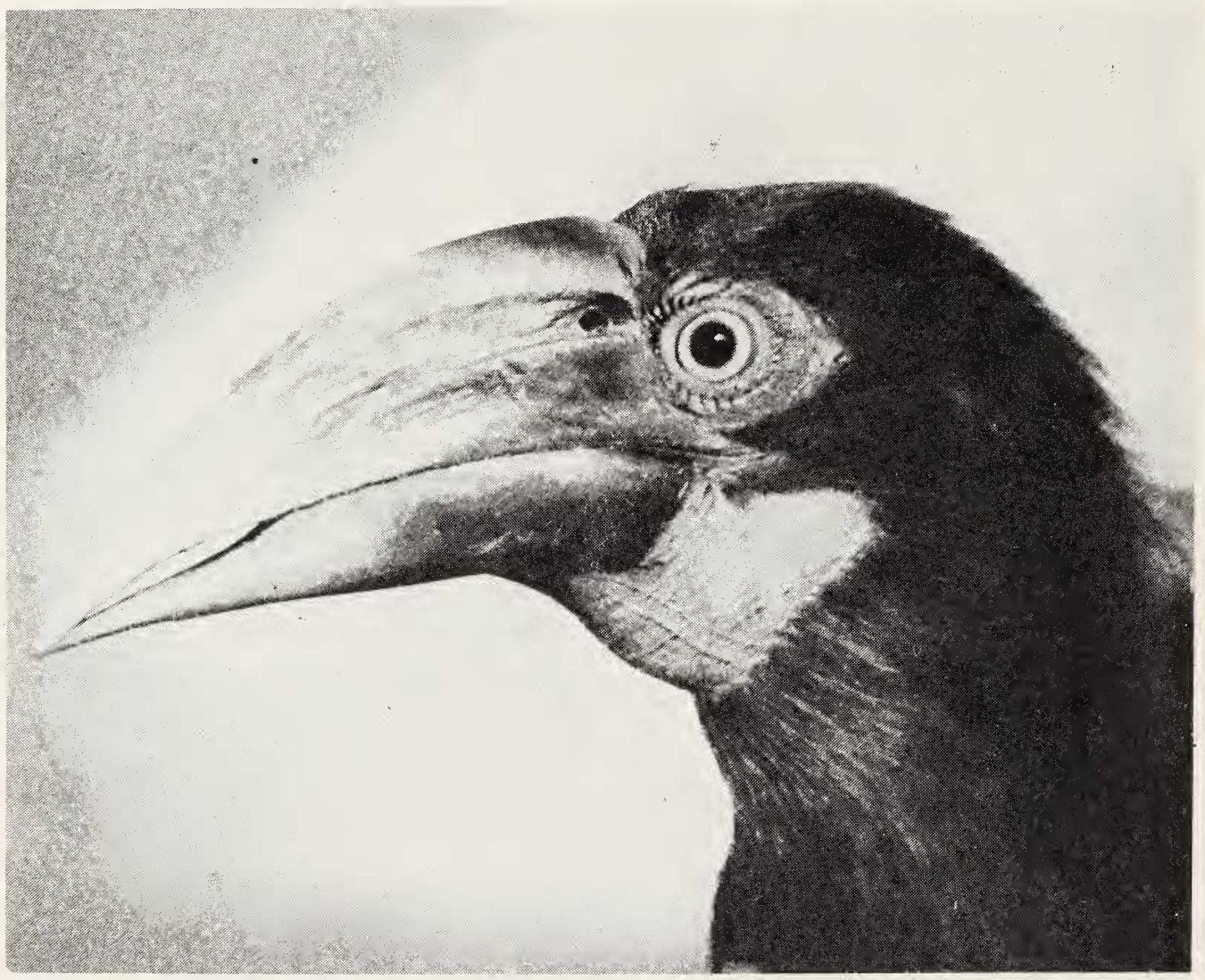
The egg (only one obtained) was earthy brown in colour. This may be due to staining. It measured 33 × 45 mm and weighed 28 g. The same nest contained a chick about a week old. It weighted 75 g and measured 130 mm from tip of the beak to vent (Plate II). The



On 26/4/1972 'A' on right, 'B' on left.

(*Photo*: Courtesy Indian Express, Madras)





Above: 'A' ♂ on 13/11/1972 *c* 9 month old.
Below: 'B' ♀ on 13/11/1972 *c* 9 month old.

(*Photos*: S. A. Hussain)

body completely naked except about 10 rudimentary rectal barbs in an arc immediately above and between the anus and the oil gland. Similar barbs, numbering about 23 along the basal half of the wing along the alar tract. The upper mandible from gape to tip was *c* 25 mm, and the lower *c* 27 mm. The depth of the bill *c* 13.5 mm and the tarsus measured *c* 16 mm, the eyes were completely closed. Both the egg and the chick were preserved.

The exact age of the two other chicks obtained could not be ascertained though it is assumed that the interval of hatching between the two was about 10 days, but this factor needs further investigation. The present observations on the growth were made from the date (13 April) the birds were removed from the next.

Of the two, one was considerably larger and ultimately turned out to be male. It was not possible to ascertain the sexes of them at this stage as both seemed to have similar plumage i.e. rufous on head and neck. The chicks were named 'A' and 'B' for the sake of convenience of description through various stages of development. (It became apparent in the final stages of growth that smaller 'B' though it started of with the rufous plumage of a male, acquired black plumage of the ♀ after the post-juvenile general moult and thereafter became a full-fledged female). Descriptions of development recorded for the period April 1972 — March 1973 etc are given below. Body measurement and weights are given separately (see Figs. 4 and 5). The actual dates of measurements vary, though taken roughly during the middle of each month. There are some obvious gaps in data as I was away on other assignments during that period.

Both the parents and chicks, kept in a makeshift cage were brought to Port Blair and then on to Madras by ship and then to Bombay by passenger train. The parent male died on board ship one week after capture. He had refused to eat. The female accepted food occasionally but did not feed the young which were kept in the cage along with her. The young however, fed voraciously. The female escaped from the cage when an enthusiastic reporter from a daily newspaper in Madras tried to photograph it in my absence. Though the newspaper sent out an appeal through its columns for information, she was never found and was believed to have died somewhere in the city of Madras. The chicks were brought to Bombay and were temporarily kept at Hornbill House. A cage measuring *c* 12′ x 20′ x 8′ was subsequently built in the compound adjacent to Hornbill House and the pair remained there till their death 6 years later.

Development :

13*th April* 1972 : 'A' — Rufous feathers on crown. Auriculars in sheath. Lores, area below the eye, nasal groove, hind-neck chin, throat and upper breast naked. The colour of skin in these areas smalt blue and rest of the area pinkish yellow. Vent, lower abdomen patchily feathered. All feathers in sheath. Upper tail coverts and lower back with a few barbs. Wing coverts well developed. A few feathers on the tarsus — oil gland swollen, and a line of feathers encircling it. Stomach greatly distended. Wing and tail in moult. Bill waxy yellow. Gular pouch pale blue. Eyelashes well developed. Irides pale blue. Soles of feet pale blue. Wing 153 mm, Bill 72 mm, tarsus 47 mm, tail 96 mm.

'B' — A few barbs appearing on the crown, nasal groove; whole back, breast, abdomen naked. Wing coverts fully grown. A few tufts of feathers around oil gland. Bill 58, tarsus 41 tail 58, weight 380 gm.

Behaviour : Call monotonous and conti-

nuous chew, chew, chew ... Both ignored their parents and vice versa, though kept in the same enclosure. Defecation was carried out by stretching the neck out, raising the wings, projecting the anal region and stepping backwards towards the edge of the enclosure. When on an open ground, the 'stepping back' is continued till the faeces is discharged. Picking up and throwing about whatever object found nearby. Pecking at the toes of the observer (resemblance to seeds?). Both voracious eaters, were fed on creamcracker biscuits, bananas, and other fruit.

May 1972 : 'A' — A line of rufous feathers in pin immediately below the gular pouch. Auriculars fully developed. Feathers on vent and abdomen fully developed. Upper back and lower hind neck patchily feathered. Base of the upper mandible swollen, showing a faint trace of wreath (furrow). Bill waxy yellow except at the base where it is reddish.

'B' — Crown, ear coverts, upper and lower tail coverts fully developed. The feathers adjoining these areas in pin.

September 1972 : 'A' — All body feathers fully grown. Crown and nape dark rufous. Throat sulphur-yellow, grading into rufous towards the upper breast where it meets the black of the abdomen. The feathers of abdomen and tarsus softer than those on the back, wing coverts and scapulars. Gular pouch light blue. Bare skin around the eye smalt blue. Bill waxy yellow, the basal tinge of red increased in tone. A gap of about 2 mm between the mandibles about 8mm from the tip.

'B' — All body feathers fully grown. Feathers adjacent to the gular skin appear blackish. Lower neck where the black of abdomen merging with the rufous of the neck seems to extend upwards. A few feathers on the crown have a barred appearance. The rufous feathers on the head and neck dark greyish on the basal half.

November 1972 : 'A' — Swollen casque of the wreath broad at forehead tapering towards the tip, about 72 mm in length. Depth of the bill including the wreath 50 mm.

'B' — Feathers on the crown (Centre streak) turning darker. A line immediately below and along the gular pouch black. Another streak across the ear coverts extending down to hind neck blackish. Swollen casque 50 mm. Depth of the bill including the casque 42 mm, gap between the mandibles about 2 mm.

December 1972 : 'A' — Depth of the bill 72 mm. Tip of the swollen casque blunted due to wear.

'B' — Black feathers in sheath in a line above the eye (almost a central streak). Similar streaks below the eye and extending upwards from the black feathers in the abdomen and breast. Another line of black feathers extending upwards from the upper back towards the crown. Rest of the neck area dark brown, depth of bill 43 mm, wreath 50 mm.

March 1973 : 'A' — Depth of bill 54 mm, 2 central tail feathers and 7th primary moulting. No body moult.

'B' — Extensive dropping of body and flight feathers. Heavy body moult. All the feathers moulting in the head and neck area black.

From March 1973, onwards the plumage of 'B' showed a marked overall tendency to become black. By the end of May the moulting was over. The moulting of the wing and tail feathers was irregular. Both the birds shed their flight feathers irregularly, sometimes even freshly moulted ones. Powdered calcium sandoz was added to the regular diet during this period. By this time 'B' attained the full adult female plumage.

In August 1973 the transverse band on the wreath turned opaque and developed a soft

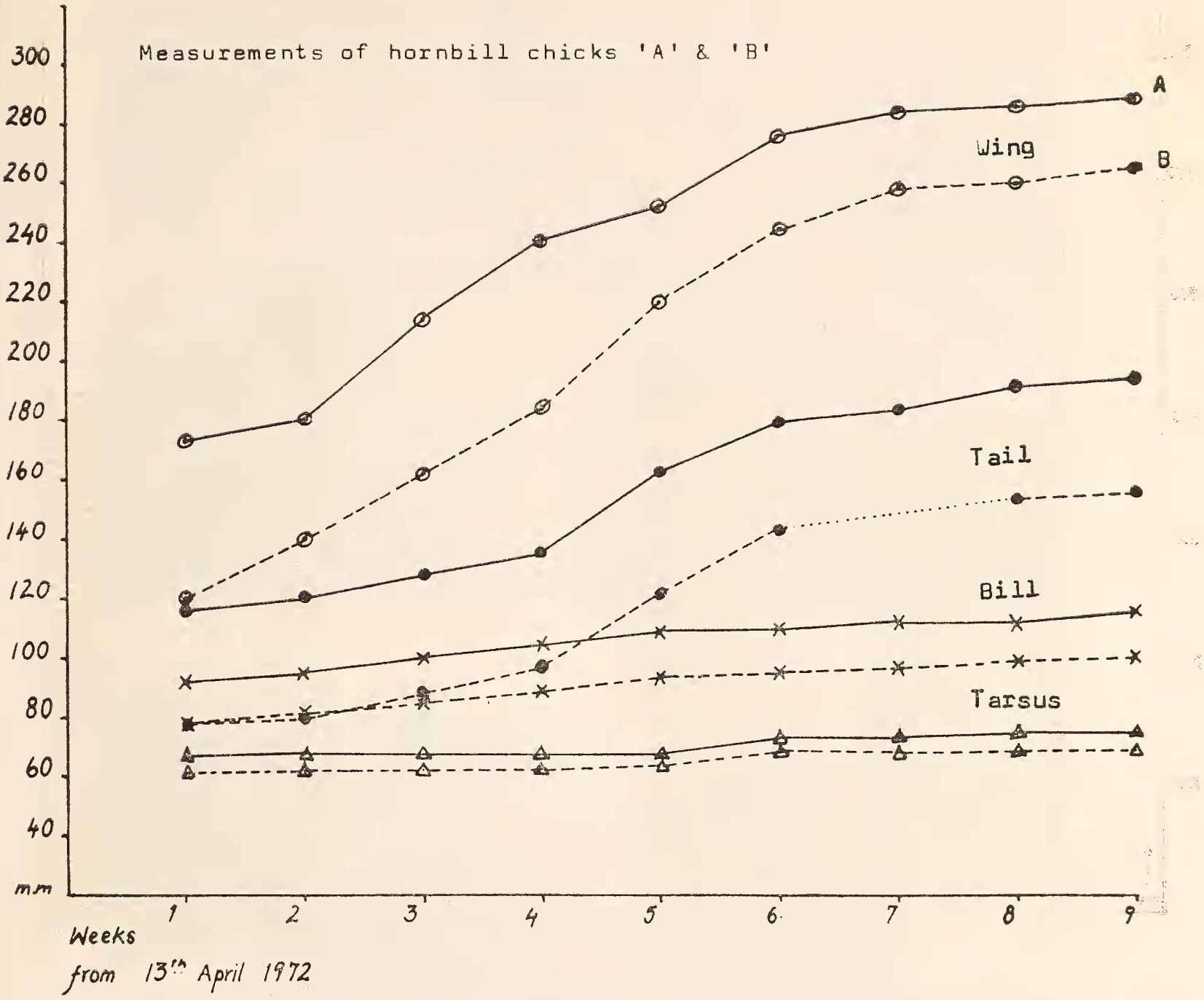


Fig. 4.

wrinkled depression where small blood capillaries were seen.

Soft parts : Colour of the irides remained pale grey in both ♂ and ♀ throughout while the eye lids of ♂ turned red in colour. Bare skin around the eye and the gular pouch blue.

Measurements of wing, bill, tarsus, and tail were noted at intervals (Fig. 4). Weights were also noted for the same period (Fig. 5). The measurements of wing and tail were discontinued after March 1973, as their tips were either breaking or wearing out as the birds constantly flew around in the cage.

Food and behaviour in captivity :

Both were fed on suttoo (powdered roasted Bengal gram) mixed with glucose powder and a few drops of ABDEC, supplemented with fruits like bananas, apple, guava, jamun (*Syzigium jambolana*) marshmelon, mango and sapota, hardboiled eggs and chopped meat was given in the initial stages.

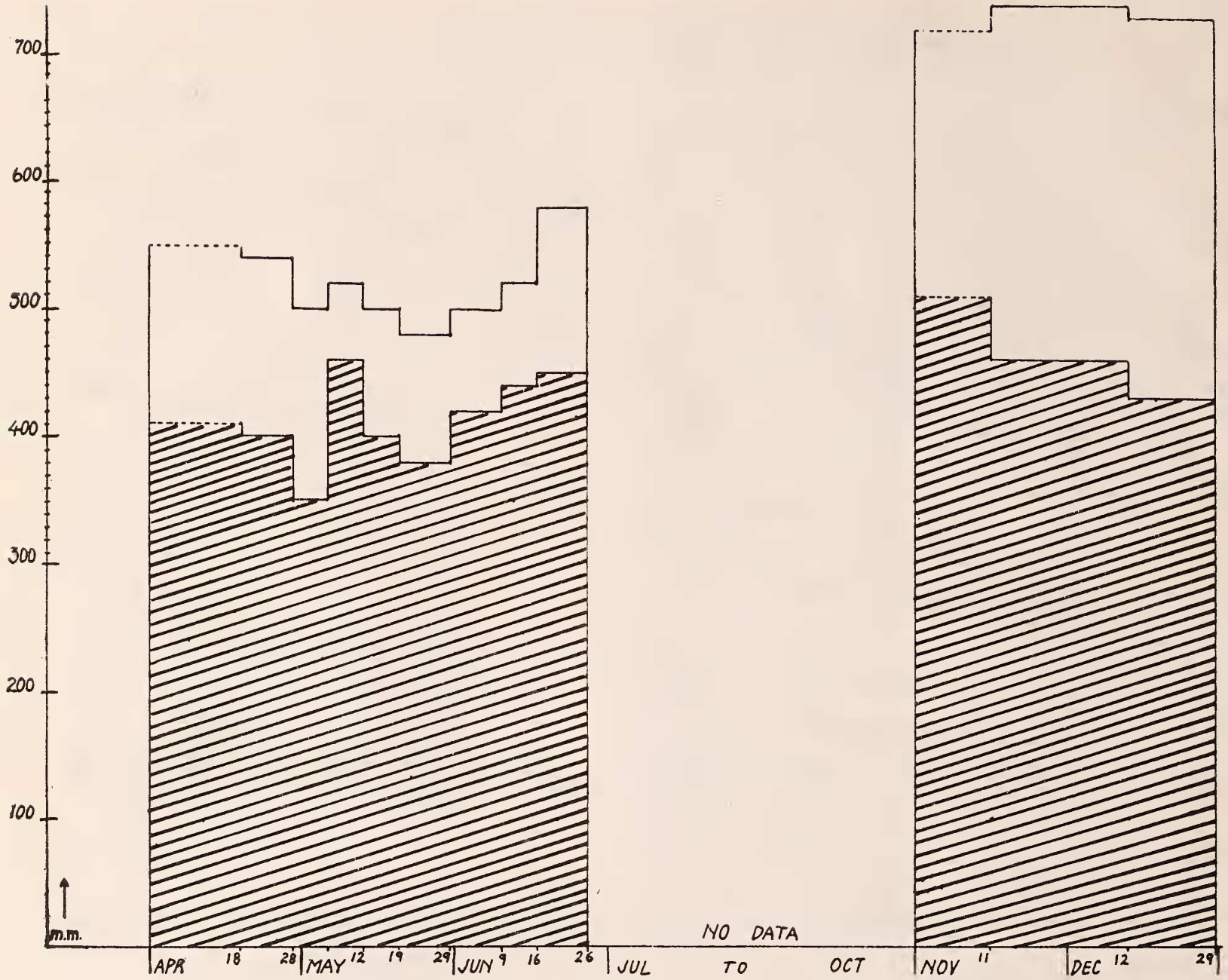


Fig. 5. Weights of chicks (blank area — male, shaded area — female)
In *Tockus* hornbills nestling weight reaches a peak at the completion of body growth indicated by tarsus and ulna measurements. Thereafter weight declines erratically untill about fledging time and once again rises to a constant level (Kemp 1976). Figs. 4 & 5 indicate here that the body growth had reached a peak around the beginning of April and Fig. 5 indicates possible fledging period around mid-May.

Sporadic jerky movements of the head, a trait also observed in adults in the wild state. Occasionally tossing up the head and rubbing the crown on upper back. An occasional fruit or a morsel of food would be brought up and swallowed again. Hard seeds are regurgitated, preening is done throughout the day at irregular intervals. Head is scratched by extending the wing, and bring up the leg over it, (indirect scratching).

'A' (♂) was aggressive towards 'B' (♀) and would not allow it to come near, often attacking and chasing it around the cage.

There was no significant change in plumage